LUBRICATION

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Edited by

L. H. CANFIELD, Ph. D.

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Correspondence is invited. Address all communications to Dr. Canfield.

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EDITORIAL

Our editorial page this month is devoted to the furtherance of the call of the Administration for the earnest and thoughtful co-operation of all citizens in the matter of food conservation. The relations of The Texas Company with the United States Government are such that we are included among the important organisms of the nation's warring machinery, and hence it is eminently fitting that we do our bit in furthering the efforts of the Administration to render its war measures effective. One of the most vital parts of Uncle Sam's task in building up an enormous war organization is to arouse the American people to the necessity for saving wheat, meat, fats, and other staples, for future use, and to be sent to our Allies in Europe.

We are reprinting below the card sent out by the United States Food Administration, with the suggestion that every reader of *Lubrication* enlist his family in the movement to observe the following pledge which is being made by millions of our American women:

To the Food Administrator,
Washington, D. C.

I am glad to join you in the service of food conservation for our nation and I hereby accept membership in the United States Food Administration, pledging myself to carry out the directions and advice of the Food Administrator in my home, insofar as my circumstances permit.

Name.....

Street.....City.....

State.....Occupation.....

Number in Household.....Occupation of Breadwinner.....

Will you take part in authorized neighborhood movements for food conservation?.....

Have you a garden?.....

There are no fees or dues to be paid. The Food Administration wishes to have as members all of those actually handling food in the home. All women over sixteen are eligible.

DIRECTIONS

Mail your pledge card to the Food Administrator, Washington, D. C., and you will receive FREE your first instructions and a household tag to be hung in your window.

If you want the button of the Food Administration send ten cents and a return addressed envelope. The shield insignia for the sleeve of the uniform will be sent with the button if you ask for it.

United States Food Administration

WIN THE WAR BY GIVING YOUR OWN DAILY SERVICE

SAVE THE WHEAT.—One wheatless meal a day. Use corn, oatmeal, rye or barley bread and non-wheat breakfast foods. Order bread twenty-four hours in advance so your baker will not bake beyond his needs. Cut the loaf on the table and only as required. Use stale bread for cooking, toast, etc. Eat less cake and pastry.

Our wheat harvest is far below normal. If each person weekly saves one pound of wheat flour that means 150,000,000 more bushels of wheat for the Allies to mix in their bread. This will help them to save DEMOCRACY.

SAVE THE MEAT.—Beef, mutton or pork not more than once daily. Use freely vegetables and fish. At the meat meal serve smaller portions, and stews instead of steaks. Make made-dishes of all left-overs. Do this and there will be meat enough for every one at a reasonable price.

We are today killing the dairy cows and female calves as the result of high price. Therefore, eat less and eat no young meat. If we save an ounce of meat each day per person, we will have additional supply equal to 2,200,000 cattle.

SAVE THE MILK.—The children must have milk. Use every drop. Use buttermilk and sour milk for cooking and making cottage cheese. Use less cream.

SAVE THE FATS.—We are the world's greatest fat wasters. Fat is food. Butter is essential for the growth and health of children. Use butter on the table as usual but not in cooking. Other fats are as good. Reduce use of fried foods. Save daily one-third ounce animal fats. Soap contains fats. Do not waste it. Make your own washing soap at home out of the saved fats.

Use one-third ounce less per day of animal fat and 375,000 tons will be saved yearly.

SAVE THE SUGAR.—Sugar is scarcer. We use today three times as much per person as our Allie s. So there may be enough for all at reasonable price use less candy and sweet drinks. Do not stint sugar in putting up fruit and jams. They will save butter.

If everyone in America saves one ounce of sugar daily, it means 1,100,000 tons for the year.

SAVE THE FUEL.—Coal comes from a distance and our railways are overburdened hauling war material. Help relieve them by burning fewer fires. Use wood when you can get it.

USE THE PERISHABLE FOODS.—Fruits and vegetables we have in abundance. As a nation we eat too little green stuffs. Double their use and improve your health. Store potatoes and other roots properly and they will keep. Begin now to can or dry all surplus garden products.

USE LOCAL SUPPLIES.—Patronize your local producer. Distance means money. Buy perishable food from the neighborhood nearest you and thus save transportation.

GENERAL RULES

Buy less, serve smaller portions.
Preach the "Gospel of the Clean Plate."
Don't eat a fourth meal.
Don't limit the plain food of growing children.
Watch out for the wastes in the Community.
Full garbage pails in America mean empty dinner pails in America and Europe.
If the more fortunate of our people will avoid waste and eat no more than they need, the high cost of living problem of the less fortunate will be solved.

HOME CARD

HERBERT HOOVER,
United States Food Administrator.

THE LUBRICATION OF AIR COMPRESSORS

By The Lubrication Engineers Association of
The Texas Company*

IN general air compressors may be divided into two classes: the single cylinder, single stage type, and the multi-stage type. In the single stage type, the air is compressed to the full desired degree of compression in one cylinder and in one operation, while in the multi-stage type the desired compression is reached by two or more stages. The single stage compressor is the one in most common use, particularly where small air supplies are required, and generally operates under a pressure of from fifty to sixty pounds per square inch.

The compression of air results in the conversion of the energy used into heat. The rise of temperature of a volume of air under compression follows certain laws, and tables have been compiled which show the theoretical temperatures the air will attain when compressed to certain pressures. The following table gives the temperature that air will attain, taking the inlet at 60 degrees F.

Gauge Pressure	Atmospheres	Final Temperature
0 lbs.	1.	60 Deg. F.
25 lbs.	2.7	234 Deg. F.
50 lbs.	4.4	339 Deg. F.
75 lbs.	6.1	420 Deg. F.
100 lbs.	7.8	485 Deg. F.
125 lbs.	9.5	540 Deg. F.
150 lbs.	11.2	589 Deg. F.
200 lbs.	14.6	672 Deg. F.

In actual practice, however, the temperatures never reach these figures, for the reason that in the economical operation of compressors it is very important that the temperatures be kept as low as possible. For this reason the compressor cylinders and cylinder heads are provided with jackets through which cold water is circulated to absorb as much of the heat of compression as possible. If the water jackets are of insufficient capacity or if too small an amount of water is circulated through them, trouble is likely to occur. A large percentage of the trouble experienced with air compressors is on single stage compressors. Examinations have shown that in many instances this is due to the fact that they are overloaded from being forced beyond their capacity, excessive heat being generated thereby.

Where the air is compressed through more than one cylinder, the temperature of the air is still further reduced by passing it through intercoolers on its way from one cylinder to another. These intercoolers connect the air discharge of the first cylinder with the suction or inlet of the second cylinder, and, in case the air is compressed successively through three or four cylinders, intercoolers are placed between each two cylinders. These intercoolers contain a number of small tubes through which the air passes and over which the cooling water circulates. In this way the air, even when compressed to 800 or 1000 pounds per

**Editor's Note.*—Papers on this subject were submitted by the following members of the Association: Messrs. W. M. Davis, Douglas L. Keys, W. A. Edmundson, H. K. Eilers, J. N. Prewitt, H. J. Wilson, Howard Cooper, John H. Young, Jr., F. A. Neale, H. W. Salbador, H. B. Joseph, J. T. Snow, C. M. Roe, A. Nielson, W. A. Ludwick, J. D. Barton, C. H. Kennerly, and J. W. McGuire.

square inch, will, after passing from the last cylinder, be comparatively cool. In fact, the final discharge from a multiple cylinder compressor is often cooler than from a single cylinder compressing to only 80 or 100 pounds pressure, especially where the single stage machine is driven at high speed.

The water side of intercoolers and water jackets should be kept free from all dirt, mud, and other foreign matter, which the cooling water is apt to bring with it. This foreign substance can be detected by watching the discharge from the jackets or coolers. The failure to observe this precaution has in some cases been responsible for air compressor explosions as jackets and coolers become very inefficient if they are coated with mud or scale. The trouble with multi-stage compressors is not usual as the intercoolers, if properly cared for, never allow the air temperature to become excessive.

The external lubrication of air compressors does not differ from ordinary external lubrication. In the case of steam driven compressors the main bearings, crank pins, cross-head pins, and cross-head guides are usually lubricated by a splash system. The crank case of the frame is filled with oil to a sufficient height to permit the partial submergence of the crank disks, and when in operation the oil is carried to or splashed over the various parts to be lubricated. After passing through the bearings, the oil is returned to the crank case and is used over and over. In some cases the crank pins are fitted with pendulum oilers with stationary cups, and the other bearings are fitted with sight feed oil cups.

In design and construction the air compressor of the ordinary or piston type is similar to a steam engine. The action, however, is the reverse of the steam engine, for in the case of the air compressor cylinder, power is transmitted to the piston through the shaft and connecting rod, instead of from it. In a simple form of compressor, the air in front of the piston is compressed until the pressure reaches a point sufficient to open the discharge valve, and the charge is then forced into the receiver through the outlet pipe. In the meantime a partial vacuum has been formed in the cylinder back of the piston which has caused the inlet valve to open, admitting air at atmospheric pressure, so that at the end of the stroke the cylinder is filled with free air for compression upon the return of the piston. The action of both the inlet and outlet valves is entirely automatic, the former opening inward and the latter outward when the pressure on the two sides becomes unequal.

So far as internal lubrication is concerned, the problems offered by the steam engine and the air compressor cylinder are entirely different. In the steam engine, moisture, which has a tendency to wash the oil from the surfaces of the cylinder and valves, is always present to a greater or less degree, requiring in most cases, the use of a compounded oil. In air compressor cylinders, on the other hand, the surfaces are dry, and so compounded oils are never used. Moreover, less oil is required for the air compressor cylinders, since the oil is not washed off the cylinder walls.

As in the case of steam cylinder lubrication, the conditions of the internal surfaces, the piston speed, and the weight and fit of the piston must be taken into consideration in selecting the proper air compressor oil. Low speeds and heavy or loose fitting pistons require a higher viscosity oil than high speeds and light or tight fitting pistons. Other

important factors which govern the lubrication of air compressors are the degree to which the air is to be compressed, the location of the air inlet, the method of applying the lubricants, the kind of valves used, and the size and kind of water jackets and intercoolers.

In the horizontal air compressor, as in the horizontal steam engine, the entire weight of the compressor piston must be sustained by the lower portion of the compressor cylinder. With this type of compressor it is, therefore, necessary to use a lubricant of sufficient body under the heat of compression to prevent metal contact, and to reduce wear to a minimum. Vertical compressors do not require as much lubricant or as heavy a lubricant as horizontal compressors.

One of the most important requirements of an air compressor oil is that it should have a viscosity sufficiently high to meet service requirements. For high pressures and temperatures an extra heavy viscosity oil, such as Texaco Ursa Oil or even Vanguard Mineral Oil should be used. For medium pressures and temperatures a heavy viscosity oil, such as Texaco Algol Oil, and for low pressures and temperatures a medium viscosity oil, such as Texaco Alcaid Oil or a light viscosity oil such as Texaco Cetus Oil should be used. The oil should have sufficient body to sustain the weight of the moving parts, to form a seal between the piston rings and the cylinder walls, and to prevent the excessive use of oil. On the other hand, the viscosity should not be too high to obtain efficient atomization or to cause excessive friction. Moreover, if an oil of too great viscosity is used, it will tend to collect any dust that may be in the air and will tend to bake on the hot surfaces and form carbon deposits. This is especially likely to happen when more oil has been used than is just sufficient to lubricate the wearing surfaces.

Another requirement of air compressor oil is that it should not be decomposed under the heat conditions to which it is subjected in the air compressor cylinder, resulting in the formation of carbon. The chief objection to steam cylinder stocks is that they easily decompose under air compressor cylinder conditions, forming sticky and hard carbon deposits in the cylinders and valves or air lines. Carbon deposits are probably the chief cause of air compressor explosions. They also hinder the working of the valves and by increasing the friction cause an increase in the temperature of the air. Carbon also has a tendency to cause bad cutting of the valves and valve seats which can result in a considerable amount of damage in a short time. The amount of carbon formed with Texaco Ursa, Algol, Alcaid, or Cetus Oils is small, due to the fact that they do not readily decompose; and any deposit which is formed is of a dry sooty nature which does not collect dust or accumulate in the cylinder or on the valves.

An extremely high flash test has been greatly over-emphasized as a qualification for air compressor oils. Even though the temperature of compression should reach the flash point of the oil an explosion would not take place, as the flash point is considerably increased by the high pressure and as a spark or flame must be introduced before the oil would flash. If carbon deposit is present, which is rendered incandescent by the increased heat of compression, an explosion may occur irrespective of the flash of the oil. The oil would have to be submitted to a temperature much

higher than its flash point before combustion would take place without the introduction of a spark or flame. A good example of combustion without the introduction of a flame is that of the Diesel Engine, which is discussed below, and in which the temperature is as high as a thousand degrees Fahrenheit.

One of the troubles commonly met with in compressors is the groaning of the pistons. Generally this can be traced to an improper fitting of the piston rings, which, being subjected to alternating pressure, set up a vibration which allows the air under compression to leak by the piston rings in an unsteady flow. This in turn, increases the vibration of the rings and results in the groaning of the pistons. This condition exists in compressors that have been in use for a considerable time without renewal of rings, and it can frequently be overcome by using a higher viscosity oil.

In steam cylinder lubrication it is necessary that the oil be atomized or broken up into small particles so that it will be carried by the steam to the surfaces to be lubricated, as well as to the exhaust valves. The same is true, to a certain extent, in air compressor lubrication, in which case the oil should be atomized by the incoming air, and carried to the surfaces of the cylinder walls and to the exhaust valves. As in the case of steam cylinder lubrication, the atomization becomes more complete with an increase in distance between the point of introduction of the oil and the valve chest.

Ordinarily the oil is introduced into the air compressor at or above the point of air intake. Where large diameter cylinders are used, particularly in the type known as the "blowing engine," a different method of introduction is required. This method consists of introducing oil at different points of the cylinder, preferably at the top, and also at the side center of the cylinder. The oil is spread over the entire length of the cylinder by the wiping effect of the piston as it travels back over the cylinder.

The greatest efficiency is obtained by the use of automatic lubricators, and many types of compressors are now equipped with these lubricators. In many cases of steam driven compressors two-compartment lubricators are used for feeding two kinds of oil, one to the steam cylinders and the second to the air compressor cylinders. These lubricators insure a uniform rate of feed irrespective of any changes in the air pressure.

It is impossible to make any hard and fast rule as to the proper amount of oil to use in a compressor. Trouble experienced with air compressors is probably more frequently due to the use of an excessive amount of oil than to any other cause. The amount of oil necessary to lubricate an air cylinder is usually about one-third or one-fourth the quantity required to lubricate a steam cylinder of the same size. If the lubricant is unsuitable, an excessive amount is required to keep the cylinders from groaning, and the result of the use of an excessive amount of oil is carbonization in the air passages, and particularly on the discharge valves. Sticking of these valves, allowing hot compressed air to flow back into the compressor cylinder, is a sign of too much oil. The discharge valves should be examined regularly, and the receiver and discharge pipes blown out. This will effectually remove all oil, water, and sediment, which may have accumulated. The trouble sometimes experienced in the lubrication of the high pressure cylinder of a three stage compressor

can usually be attributed to excessive amounts of oil.

In one plant equipped with a small single stage machine compressing air to ninety pounds pressure, over a gallon of oil a day was being used and they were continually having carbon trouble, while in another plant equipped with the same make and type of compressor, performing the same duty, only a pint of oil was used per day, and no carbon trouble was experienced. In the first case the large quantity of oil accumulated around the discharge valves and passages, and being exposed to the heat of the compressed air, would bake on, layer after layer, and unless cleaned out frequently would completely stop up the air passages. In the second instance the amount of oil used was sufficient to lubricate the wearing surfaces, yet not enough to accumulate and form carbon or coke deposit.

Another cause of complaint has been found to be due to the use of unsuitable oils, such as compounded steam cylinder oil, in the air compressor. These oils, besides being very viscid, contain much free carbon matter, which clings to the orifices of the discharge valves and seats gathering dirt from the air. Under the influence of the dry heat together with the dirt from the air, these oils soon become carbonized and form a hard flinty substance that requires considerable labor for its removal, while the animal oil used in compounding separates and forms a sticky residue which under the dry heat conditions decomposes, liberating a free fatty acid. This will honeycomb or etch the cylinder and piston surfaces and also make the piston rings more brittle.

One of the engineers reports a series of tests which he conducted to determine the effect that heat would have on various lubricating oils when subjected to high temperatures such as exist in an air compressor cylinder. As he says, the best way would be to test the oils in the cylinders of an air compressor, but as in most types of compressors the valves are in one large heavy casting, which, with the water pipe connections, make them difficult to remove, not many engineers care to go to the bother of doing it.

He then devised a plan whereby he could determine approximately the action of different oils under heat conditions somewhat similar to those which exist in an air compressor cylinder. This was accomplished by taking a block of cast iron about six or eight inches square and two inches thick and placing it on a layer of dry sand in a shallow iron pan, packing the sand close around the cast iron block, and placing the pan over a gas burner. The upper surface of the block was polished and a hole about ½ inch deep drilled in it, large enough to hold the mercury bulb of a thermometer, cylinder oil being poured into the hole so as to make a close heat contact.

Air, taken at a temperature of 60° F. and compressed to 125 pounds per square inch gauge pressure, will theoretically attain a temperature of 540° F., but in actual practice, owing to the water flowing through the heads and around the cylinders, the temperature of the discharge air seldom, if ever, goes above 400° in a single cylinder compressor, so the block was heated to this temperature.

When the thermometer showed 400° F. a certain oil was taken that had been used at one compressor plant. This was a very light bodied, paraffine base oil, about like a spindle or ice machine oil. A drop

of this oil was allowed to fall from the point of a lead pencil from a height of two inches onto the block. In ten seconds it had spread out to a circle of 1⅛ inches, smoked slightly, and dried up almost instantly, thus indicating that it was a very poor compressor lubricant.

Then a drop of a slightly heavier oil, such as would be suitable for use in turbine and motor bearings, was tried. This spread out quickly to a diameter of 1½ inches, smoked slightly and dried up in two minutes. It was but little better than the first oil.

A still more viscid oil, about like a medium bodied engine and machine oil, was then dropped on the hot surface. It spread out slowly to a diameter of 1¼ inches, smoked slightly, and the surface was oily after five minutes. In the meantime the temperature, as shown by the thermometer, had gone up to 420° F.

A still heavier oil, such as is usually used in gas engines, did still better, even after the temperature had gone up to 450° F. It smoked but little, and a good trace of oil was still on the block after ten minutes.

A steam cylinder oil was then tried. It did not smoke or dry up, but after a while it became thick and gummy.

Even at the highest temperatures the engine oils burned up clean, leaving no trace of dry coke or carbon matter, which tends to confirm the theory that the hard formation often found in and around the discharge valves of air compressors is due largely to the presence of dirt in the air which adheres to the oily surfaces and which, under the continuous dry heat, becomes baked and burnt on.

The deductions that may be drawn from these crude tests are that for such temperatures as would be encountered in a single stage compressor, compressing to 125 pounds, a high grade filtered mineral oil of moderately high vaporizing point, suitable viscosity, and especially low in carbon content, such as Texaco Alcaid or Texaco Ursa Oil, will give best and most economical results. If such an oil is used in moderate amounts, if the cooling water is sufficient, if the water jackets of the cylinders and heads do not become choked with mud and sediment, and if the air inlet is properly located, no trouble will be experienced with lubrication.

The location of the air inlet on an air compressor is of great importance, and extra care should be used in placing it. It is surprising what a large amount of abrasive material can be passed through a compressor without the cylinder walls or valves being scored. Troublesome conditions usually develop from a continuous circulation of abrasive matter in the air in the valve gauges, where it accumulates with oil which adheres to the surface of the valves, and eventually becomes carbonized from continuous subjection to the temperatures caused by the compression of the air. At one plant where trouble was experienced with carbon deposit, the compressor took its air from just outside the engine room and close to a dirt road. In dry weather clouds of dust were thrown up by passing teams, and the dust was sucked into the compressor. Changing the inlet so as to take air from above the roof remedied this trouble.

The lubrication of the air compressor constitutes an important part of Diesel Engine lubrication. In the Diesel Engine the gases of combustion are exhausted after the power stroke and the cylinders filled with fresh air which is com-

pressed by the piston on the up or out stroke. Instead of the fuel entering as vapor and being ignited by means of an electric spark, as in the case of the ordinary internal combustion engine, the fuel oil is forced into the cylinders by means of compressed air. The air that has been taken into the combustion cylinders is compressed by the pistons to such a high pressure and correspondingly high temperature that the fuel oil which is injected just at the completion of the stroke and which has been broken up into minute particles by having passed through an atomizing valve, in coming in contact and mixing with the highly heated air, ignites and in doing so drives the piston on its downward or power stroke. This ignition, however, as some engine builders are careful to state, is not exactly an explosion, but more in the nature of a constant slow combustion. As the pressure of the air in the combustion cylinders ranges from 500 to 800 lbs. per square inch, it is obvious that the fuel oil, in order to get into the combustion cylinders, must be subjected to still greater pressure. So it is customary for Diesel Engines to be fitted with compressors that will supply air of from 800 to 1100 lbs. pressure.

These compressors are of the multiple stage type, in which the air is compressed successively through two or three cylinders. In the first cylinder it is compressed to 40 to 80 lbs., in the second cylinder to 200 to 300 lbs., and finally in the third cylinder the pressure reaches 800 to 1100 lbs., per square inch. As the air passes through intercoolers in its passage from one cylinder to another it reaches its maximum pressure in a comparatively cool state. The air then passes to steel bottles or containers which allow any moisture that the air may contain to precipitate and also acts as a storage reservoir to draw from when starting the engine. These compressors are usually connected directly to the main engine shaft and form a part of the engine.

The Texas Company has developed a lubricant, Texaco Ursa Oil, which is suitable for the entire Diesel Engine, including power cylinders, air compressor, and external parts.

Air compressors exposed to weather conditions, such as those used on electric railway cars, require a lubricant for winter use which has a low cold test. The Texaco air compressor oils are low cold test oils, and will meet all temperature requirements.

While air compressor explosions occur at rare intervals, the fact should be emphasized that properly operated and properly cared for compressors are as harmless as steam engines. The cause of isolated explosions is still a disputed matter, though some phases of the question are now generally agreed upon by engineers familiar with air compressor practice. In the first place, the theory that these explosions are due to the use of an oil with a comparatively low flash point is thoroughly discredited, as they occur more frequently where a high flash oil is used. In the second place, it is generally agreed that the explosion is due to the accumulation of carbon deposits in the air lines. This deposit in turn is caused either by the use of an unsuitable oil which decomposes, or to the use of an excessive amount of oil, or to the improper location of the air inlet. The belief that the explosion is always produced by the ignition of a volatile mixture, usually of vaporized oil and air, though possibly of coal dust and air, in the air tanks

or lines, is questionable in view of the fact that the small amount of oil volatilized in the air compressor cylinder would be insufficient to form an explosive mixture with the air, as this volatile matter is constantly being carried off with the air. It could only be in a case where a very excessive amount of oil was used or where pockets of oily residue were allowed to collect that a sufficient amount of vaporized oil could collect to form with the air an explosive mixture. Even in such a case the cause of the explosion would not be the vaporized oil but would be some other factor which produced a spark or flash. The probable source of this spark is again the carbon deposit which may be responsible for a sufficient increase in temperature, by restricting the air passage and thus increasing the pressure, as to cause the carbon to become an incandescent mass. It is not improbable that in some cases this glowing mass of carbon may weaken the tensile strength of the air receiver or the air lines to such an extent that they are no longer able to withstand the pressure of the air, the result being an explosion.

REPORT ON TEXACO URSA OIL

Erskine, Minn., July 1, 1917.

THE TEXAS COMPANY,
202 Newton Bldg.,
St. Paul, Minn.

Gentlemen: Your Mr. F. H. Knowlen called on me a few weeks ago as usual and happened to see my semi-annual expense report sheet. This record, as applying to lubricants, shows the price per gallon, the amount of oil used, the number of days the engine operated, and the cost per day. During the months of January and April I had tried out two different oils besides "Ursa Oil" and the comparative figures were noted by Mr. Knowlen, who asked that I send you a copy of the report sheet together with a letter telling of my experience with the different oils.

We have a 25 h. p., two cycle, type "Y," special electric Semi-Diesel Fairbanks-Morse & Co. oil engine. I have tried out two different brands of oil besides "Ursa Oil" but found they would not stand up with "Ursa Oil" for three reasons: first, carbon; second, weakened compression; third, incapability of maintaining long life.

First, let me tell you about some of the arguments put up by some of your competitive companies' salesmen. After using about 20 or 30 gallons of a competitive oil, the salesman called on me, and I told him of the carbon trouble his oil was giving me. He then tried to tell me that the carbon came from the kerosene and not from the oil. Following his call, I used a few gallons of "Ursa Oil" and my carbon trouble disappeared. I used up the rest of his oil (one barrel) and my carbon trouble came back again. I lost from two to three hours' sleep every Sunday morning "dinging" up for the coming week. The carbon was so hard and thick in the exhaust port elbow that I had to chisel it out with a heavy hammer and a three foot chisel I borrowed from our blacksmith. There was also a deposit of gummy grease-like substance in the air port that I had to scrape out. Now, let me make myself understood, I said CHISEL not scrape from the exhaust elbow, and used a 1½-lb. hammer to get the carbon loose; and, gentlemen, that is not stretching it at all. I've used a barrel of "Ursa Oil" since and haven't had a bit of carbon trouble. Funny, isn't it? I use the same grade of kerosene I did before.

After using about 20 or 30 gallons of "Ursa Oil" my helper tried to turn the engine over against compression (not knowing that the relief valve was closed) and found the compression so strong that it threw him back from the flywheel. He looked surprised for a second, and asked what I had done to give it so much compression.

In shutting down before using "Ursa Oil" the engine used to coast along until the compression stopped it, and it would stop up against compression with a "whizz" and stick there; sometimes it would stop with a grunt as though the piston was dry. Several times I had to break the piston loose by prying down on the flywheel spokes with a long bar. It would give a snap and then let go. I was never able to "spot" the engine by hand just after shutting down; it seemed to bind, and I could get on the flywheel and

jump down on one of the flywheel spokes without moving it. The piston never stops up against compression now, and the engine has compression enough to throw the piston back, so that the flywheels rock back and forth until the engine stops. It never sticks and is always easily spotted by hand.

Once, while using competitive oil, the crank bearing grooves clogged up with a gummy or carbon-like substance, and would have burned out the bearing had I not been in the engine room at the time. I have had the bearing off four times since, and find the grooves nice and clean and the bearing well oiled.

The engine never gets dirty as it used to; the flywheel, foundation and floor are always clean.

I used to throw away all the discharged oil because it had a gritty feeling; it looked and smelled as though there was keroesne floating on top. I was afraid to use it on my water pump plunger for fear it might cut. But in the discharged "Ursa Oil" I find no grit, no kerosene, and I use it on my pump freely. I am saving my discharged "Ursa Oil" and have ordered a filter; and I expect to save about half of next month's oil bill.

I am positive I could cut down on the feed of the lubricator if my engine had a solid foundation. It stands in the mud twenty feet from the shore of the beautiful Lake Cameron, and the building and surrounding lots vibrate with the pulsation of the engine.

I wish to state that as long as I am able to obtain "Ursa Oil" I'll use no other. I am enclosing a copy of the oil report sheets. Hoping same will interest you, I am

Most respectfully yours,

K. W. MENARD,
Engineer in charge of
Erskine Municipal Electric Light & Power Plant, Erskine, Minn.

SEMI-ANNUAL OIL REPORT—*July 1, 1917*

		Gallons Used	Price per Gallon	Cost	Days Operated	Cost per Day
January—	Competitive Oil	20	28c	$5.60	16	35c
	Competitive Oil	5½	38c	2.09	7	29.9c
	Texaco Ursa Oil	4½	45c	2.02	8	25.3c
February—	Competitive Oil	15	38c	5.70	28	20.4c
March—	Competitive Oil	22	38c	8.36	31	27c
April—	Competitive Oil	15¼	38c	5.795	16	36.2c
	Texaco Ursa Oil	7¾	45c	3.4875	14	24.9c
May—	Texaco Ursa Oil	13¾	45c	6.1875	31	19.95c
June—	Texaco Ursa Oil	11¾	45c	5.2875	30	17.6c
Oil used on bearings, etc., entire 6 months		5½	38c	2.09	181	1.15c
Total		121		$46.61	181	25.8c

COMPARATIVE SUMMARY

	Competitive Oil "A"	Competitive Oil "B"	Texaco Ursa Oil
Total gallons used	20	57.75	37.75
Total days operated	16	82	83
Gallons used per day	1.25	.705	.455
Price per gallon	0.28	0.38	0.45
Cost of oil (total period)	5.60	21.95	17.00
Cost of oil per day	0.350	0.268	0.205

Reduction over Oil "B"
Gallons per day ..... .250 or 35.5%
Cost per day ..... .063 or 23.5%

A saving of 35½% in consumption, and 23½% in cost shown in the face of 18½% higher price of "Ursa." This also was accompanied by elimination of extreme carbon difficulties, an increase in compression, and perfect lubrication at all times. Furthermore, the oil "B" was not fit for re-use, whereas Ursa is filtered and used on other equipment.

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Date	Amount Used	Date	Amount Used	Date	Amount Used	Date	Amount Used
6- 1	2 qts.	6-11	2 qts.	6-21	1 qt.	6-26	1 qt.
6- 2	1 qt.	6-12	1 qt.	6-22	2 qts.	6-27	3 qts.
6- 3	1 qt.	6-13	2 qts.	6-23	1 qt.	6-28	1 qt.
6- 4	2 qts.	6-14	2 qts.	6-24	2 qts.	6-29	1 qt.
6- 5	2 qts.	6-15	1 qt.	6-25	2 qts.	6-30	2 qts.
6- 6	2 qts.	6-16	1 qt.				
6- 7	2 qts.	6-17	1 qt.				47 qts.
6- 8	2 qts.	6-18	1 qt.				or 11¾ gals.
6- 9	1 qt.	6-19	2 qts.	11¾ gals. at 45c equals $5.2875.			
6-10	1 qt.	6-20	2 qts.	An average of 3.13 pts., or 17.6c per night.			

CRATER COMPOUND

SOME time ago a comparative test on ten Farrel Rubber Mixers was concluded at a Massachusetts factory. The five mills on which the competitive grease was used were operating entirely on rubber containing a considerable amount of compound, whereas the five mills to which Crater Compound was applied were operating part of the time on rubber in a cruder state, resulting in the use of more power and consequently a greater friction to be overcome by the lubricant. The result of the test was as follows:

Date of Applications	*Amount Applied to Mills* Crater Compound (5 mills)	Competitive Grease (5 mills)
Feb. 15	5 oz.	3 lbs. 11 oz.
19	6 oz.	None applied,
23	5.5 oz.	2 lbs. 14.5 oz.
27	7 oz.	None applied
Mar. 2	7.5 oz.	2 lbs. 14 oz.
Totals	1 lb. 15 oz.	9 lbs. 7.5 oz.

Saving of Crater Compound over competitive grease, 79 per cent.

It will be noticed that applications were made twice a week where they were made only once a week with the grease. This was done because I considered it better to lubricate them twice a week instead of endeavoring to put on an extra large quantity with the purpose of lubricating them once a week.

The amount of time saved by installing gear pans to lubricate the most difficult gears will be more than sufficient to permit the oiler to lubricate the gears that are running open twice a week. In addition the gears will be much better lubricated, resulting in longer life.

The following applications were made to two rubber churns having driving pinions of 6.5″ with 2.25″ face, and driven gears of 25.5″, running 20 r. p. m.

Date of Applications	Crater Compound (1 churn)	Competitive Grease (1 churn)
Feb. 19	1 oz.	3 oz.
23	1 oz.	2 oz.
27	1 oz.	1.5 oz.
Mar. 2	1 oz.	2 oz.
Totals	4 oz.	8.5 oz.

Saving of Crater Compound over Competitive Grease, 53 per cent.

The writer made all applications of Crater Compound, while the grease applications were left to the oiler with the advice to put a sufficient amount of lubricant on to keep the gears lubricated. At no time during this test did the gears that were lubricated with Crater Compound show signs of insufficient lubrication, showing that the amounts applied by the writer were ample. It was apparent that the amount of grease that was applied by the oiler could not have been reduced without showing insufficient lubrication.

(Signed) W. O. KROENKE
Engineer, The Texas Company.